Armed Forces College of Medicine

AFCM

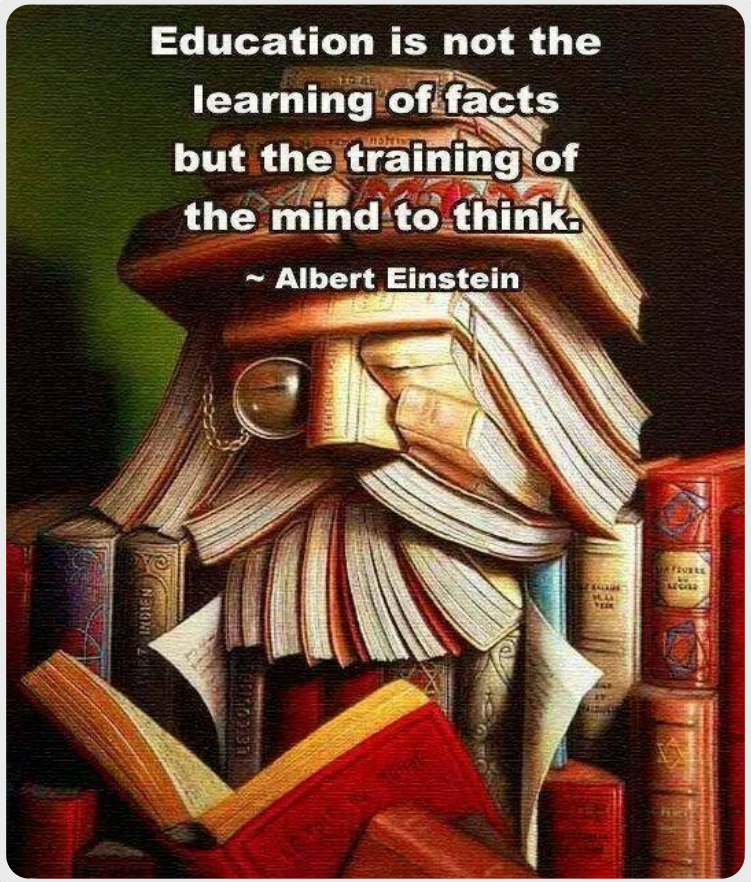
Cardiopulmonary module

Clinical Integrated Cases

Session 3

Basic Science Principles for Clinical Reasoning

1- Critical thinking
2- Introduction to common forms of disease
3- Apply basic knowledge in a realistic clinical scenario.
4- Interpersonal skills-(share and apply your knowledge)… communication…patient safety
5- Life long self-directed learning



Case co-ordinators

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Case : check up

Sharing departments

- Cardiology
- Histology
- Pathology
- Pharmacology
- Physiology

An accidental discovery in a check up

Maryham is 40 years married woman. She is attending for a routine appointment about her contraception.

Medical history

From her records, the family medicine doctor noticed that Maryham's **blood pressure has increased** since her last check twelve months ago.

She **smokes** 1 pack/day for the last 10 years

No notable medical history.

Family history:

Her **father is hypertensive**

An accidental discovery in a check up

Examination:

Vital signs

Blood pressure: **158/94 mmHg**.

Pulse rate: **72 beats per minute** and regular

Temperature: 37°C

Respiratory rate: 17cycle/min

BMI: 28

No pallor, jaundice nor cyanosis

Discussion

1- Is Maryham hypertensive?

Justify your answer

We have to confirm the diagnosis

BP should be checked at least in 3 different occasions.

Under complete resting conditions.

2- What is the grade of hypertension of Maryham?

Table 1. ACC/AHA, ESC, and NICE (UK) Guidelines for the Management of Hypertension With Special Emphasis on Care of Young Patients

Office Blood Pressure	120–129/<80	SBP, 130–139 or DBP, 80–89	SBP ≥140 or DBP ≥90	BP ≥160–179/ 100–109	SBP ≥180 or DBP ≥110
Classification					
ACC/AHA (2017)	Elevated	Stage 1	Stage 2	Stage 2	Stage 2
ESC (2018)		High normal	Grade 1	Grade 2	Grade 3
NICE NG136 (2019)			Stage 1	Stage 2	Severe
Treatment threshold					
ACC/AHA (2017)	Lifestyle	Treat if CVD or a 10-y ASCVD* risk >10%	Treat	Treat	Treat
ESC (2018)		Lifestyle advice but treat if high risk	Low-moderate risk: treat if lifestyle fails. High risk: treat	Treat	Treat
NICE NG136 (2019)			OD/CVD, diabetes mellitus, or 10-y CV risk >10%	Treat	Treat

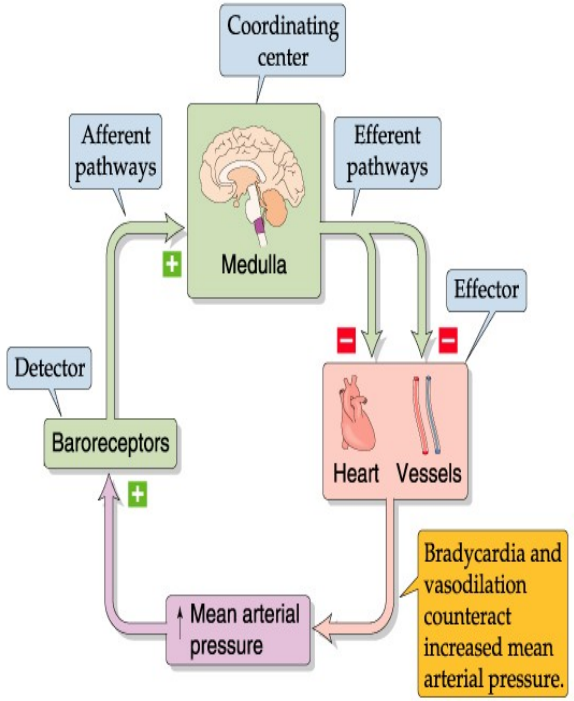
3- Differentiate between the Long and short term regulation of arterial blood pressure

Arterial blood pressure regulation

Short-term regulation	Long-term regulation
Act within **seconds- few minutes**	Developed over **days**
Adjustments are made by alterations in **cardiac output** and **total peripheral resistance**	control involves adjusting **total blood volume** by restoring normal salt and water balance through mechanisms that regulate urine output and thirst
Nervous	**Renal**

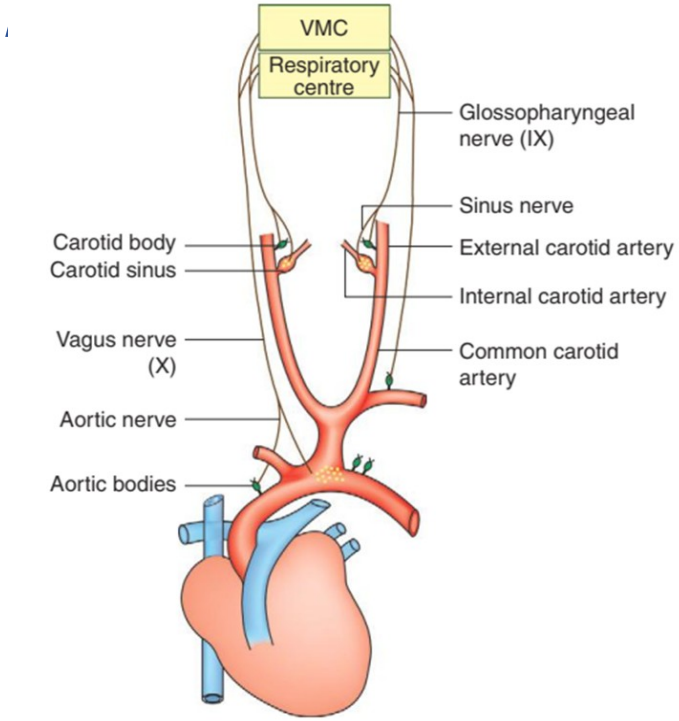
Rapid Nervous mechanisms

Baroreceptor



Stimulus:
Sensitive to changes in both:
Mean Arterial Pressure (60 - 160 mm Hg)
Pulse Pressure

Chemoreceptor



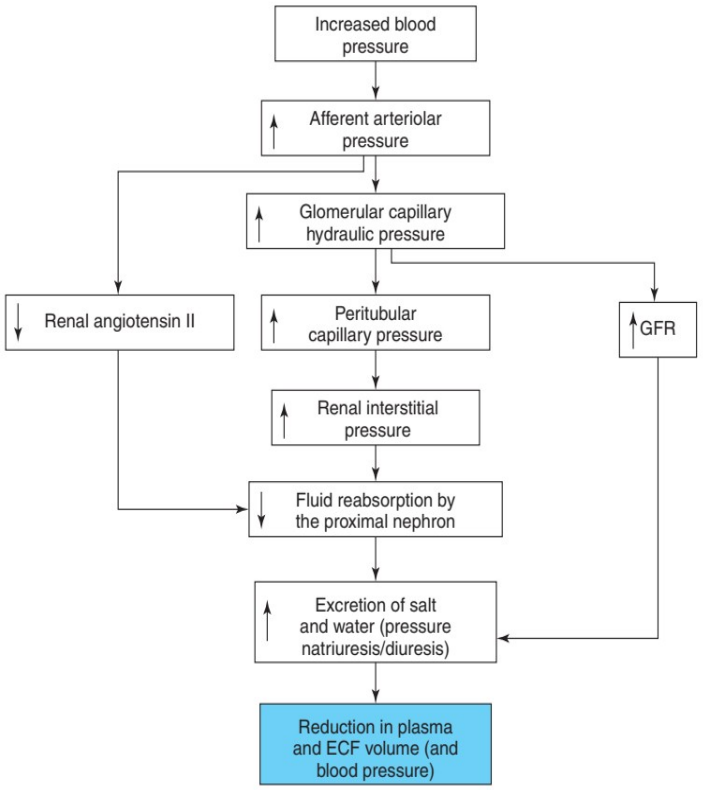
Stimulus:
Marked fall in ABP below 80 mmHg (*e.g. Hemorrhage*)
↓↓Blood flow to these receptors → (*Hypoxia of*)

Brain ischemic response

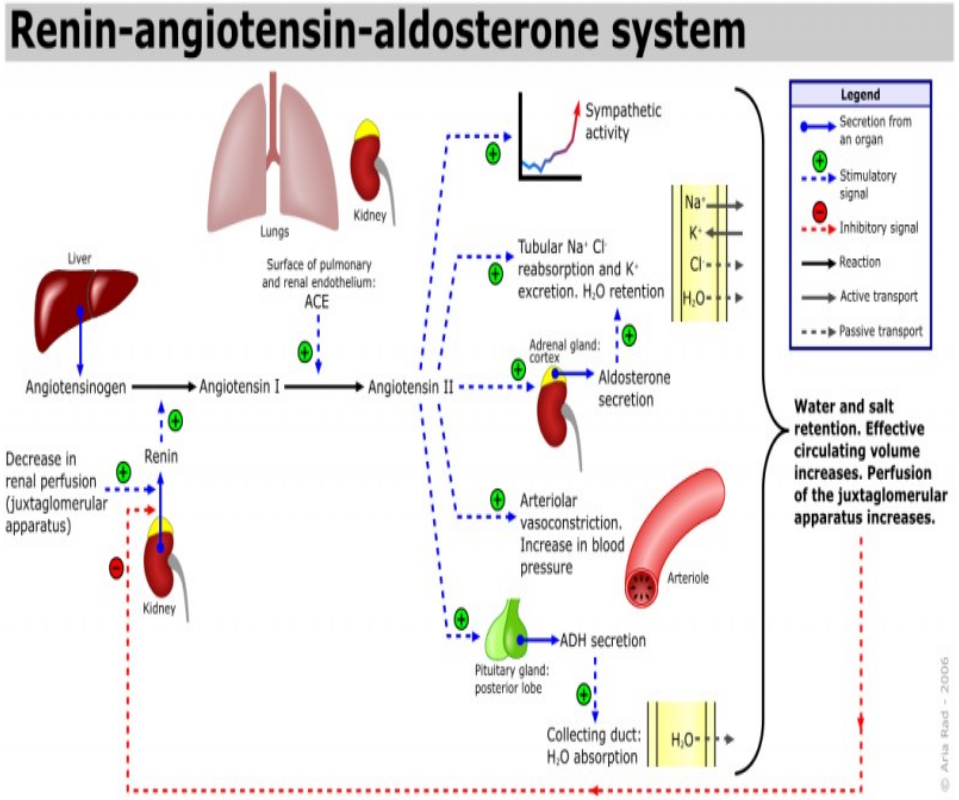
Stimulus:
Decreased arterial blood pressure (hypotension)
Only if ABP < 50mmHg

Long term regulation

Renal pressure natriuresis

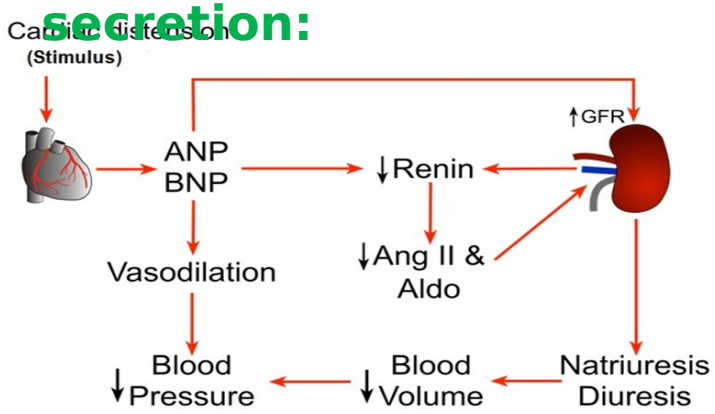

Increased blood pressure
Afferent arteriolar pressure
Glomerular capillary hydraulic pressure
Renal angiotensin II
Peritubular capillary pressure
GFR
Renal interstitial pressure
Fluid reabsorption by the proximal nephron
Excretion of salt and water (pressure natriuresis/diuresis)
Reduction in plasma and ECF volume (and blood pressure)

Renin-angiotensin-aldosterone system

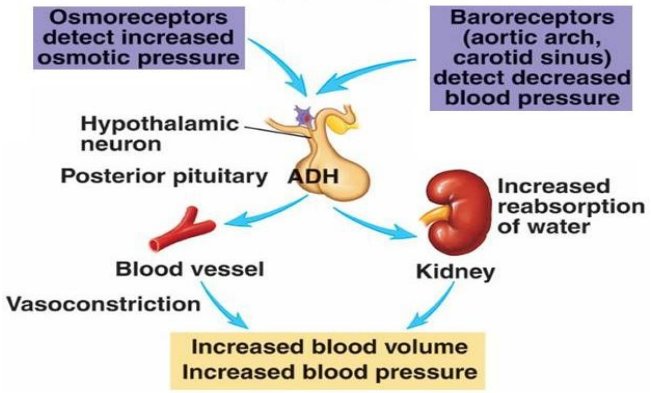


Hormonal regulation

Atrial natriuretic peptides (ANP) secretion:



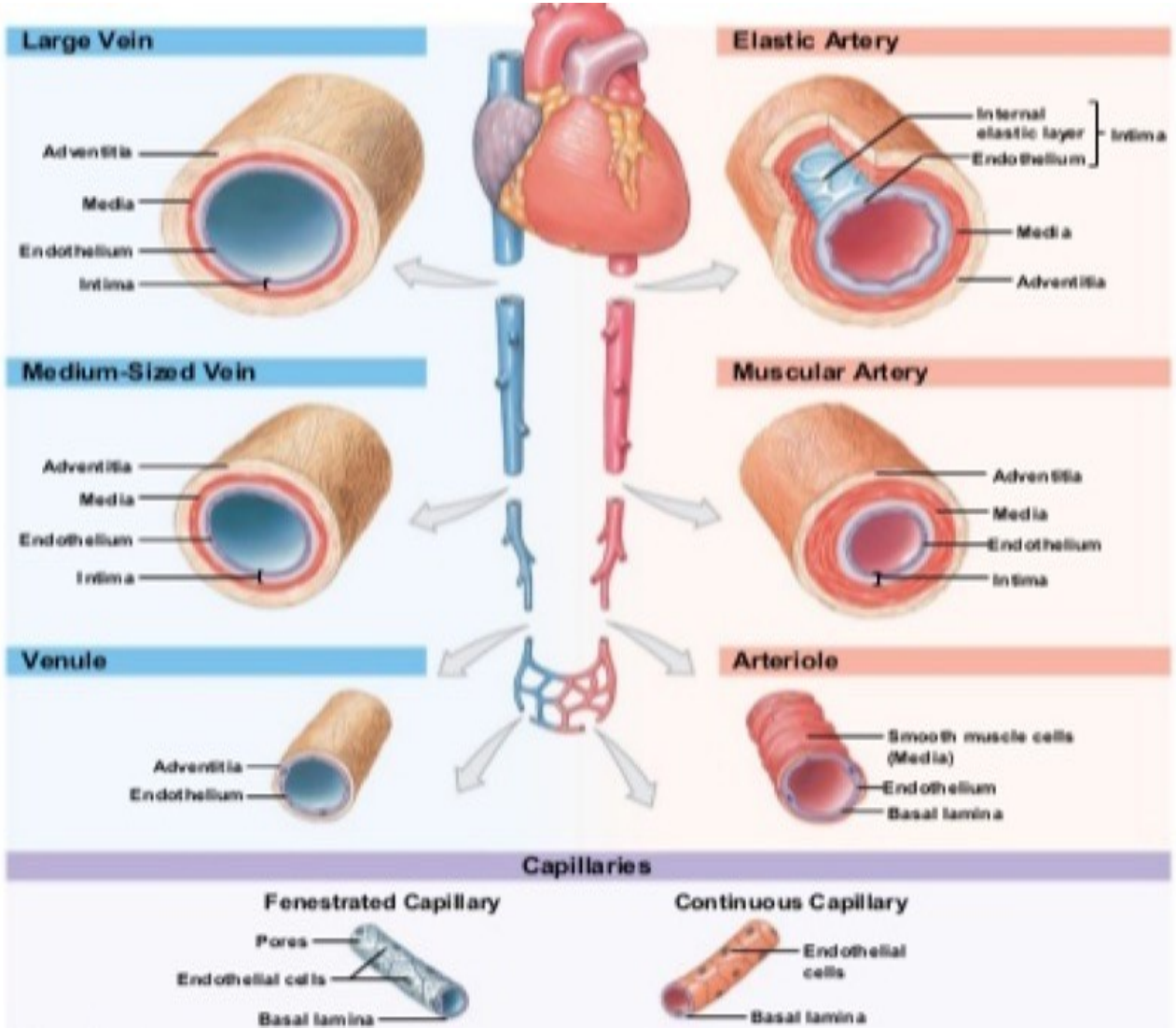
Anti diuretic hormone (Vasopressin) secretion

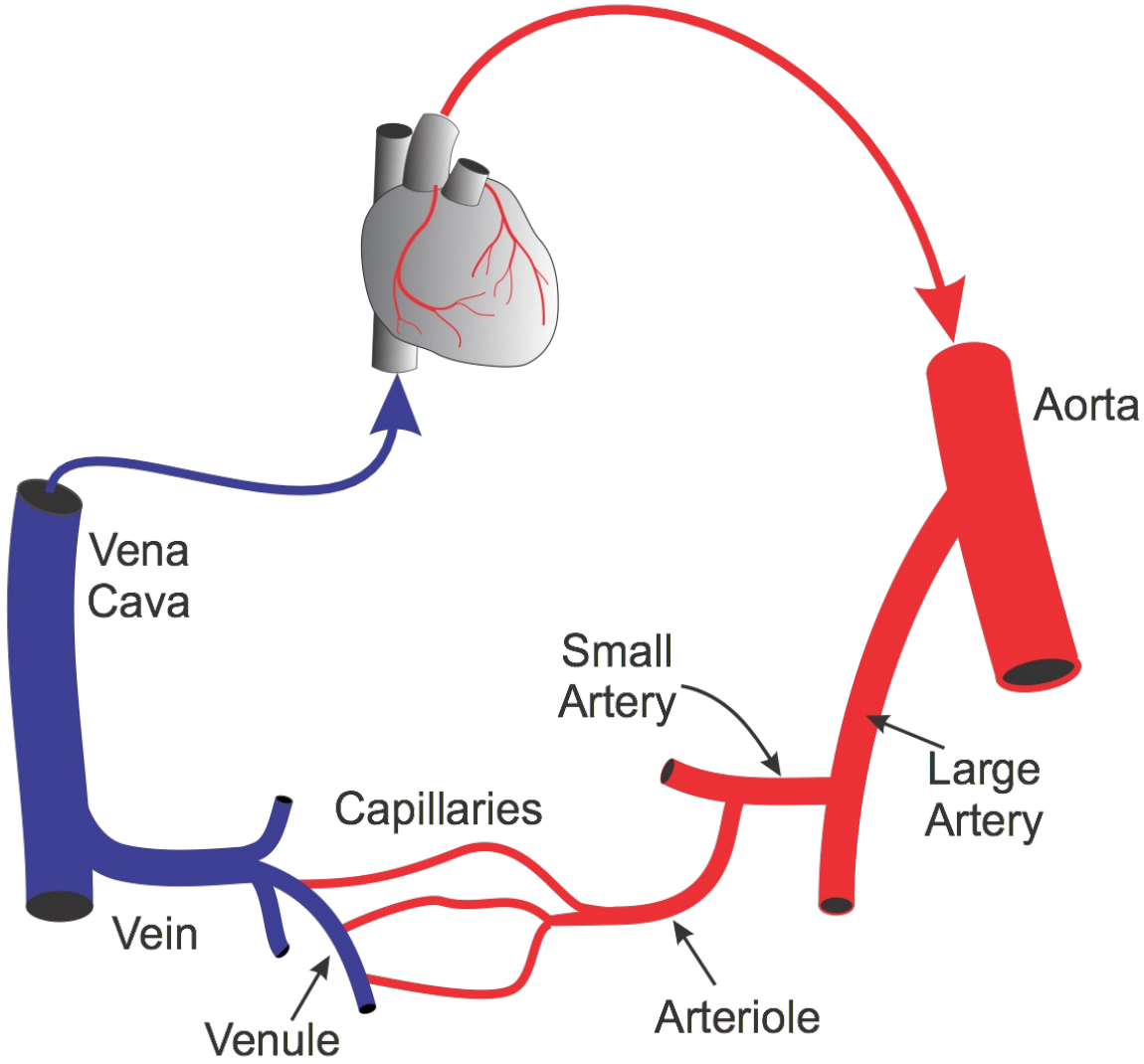


4- a- Which type of blood vessel is mainly responsible for controlling blood pressure?

B- What is the structure of this blood vessel?

The vascular system





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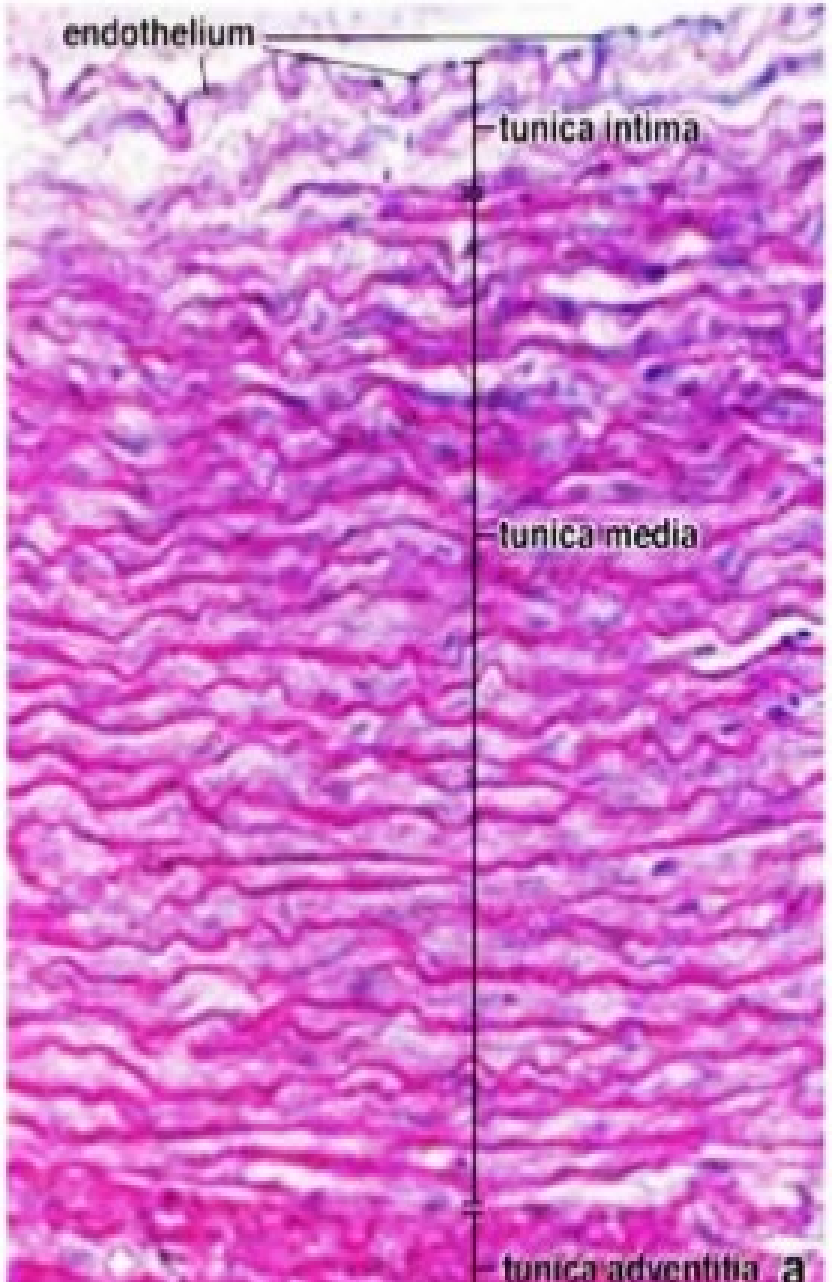
Generally, the wall of blood vessels is composed of three c



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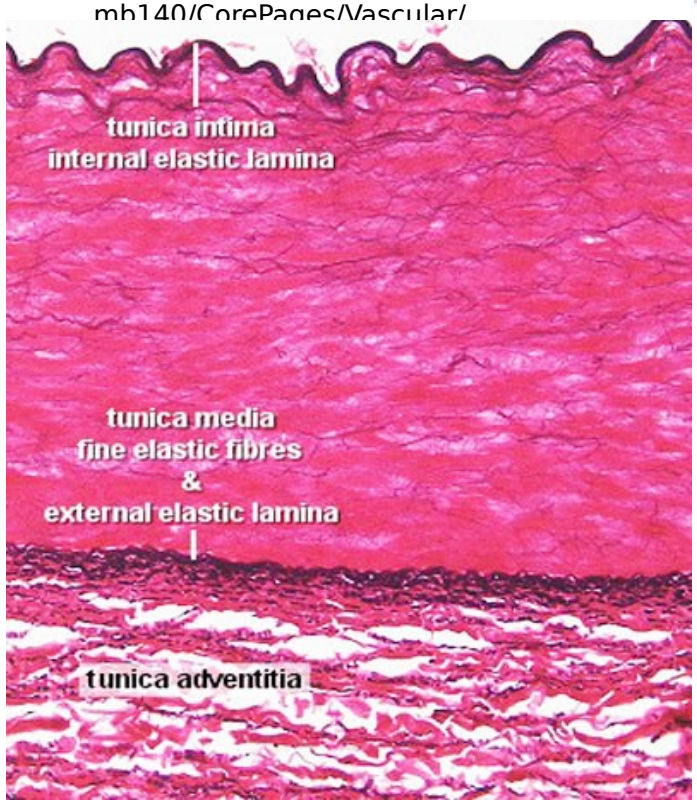

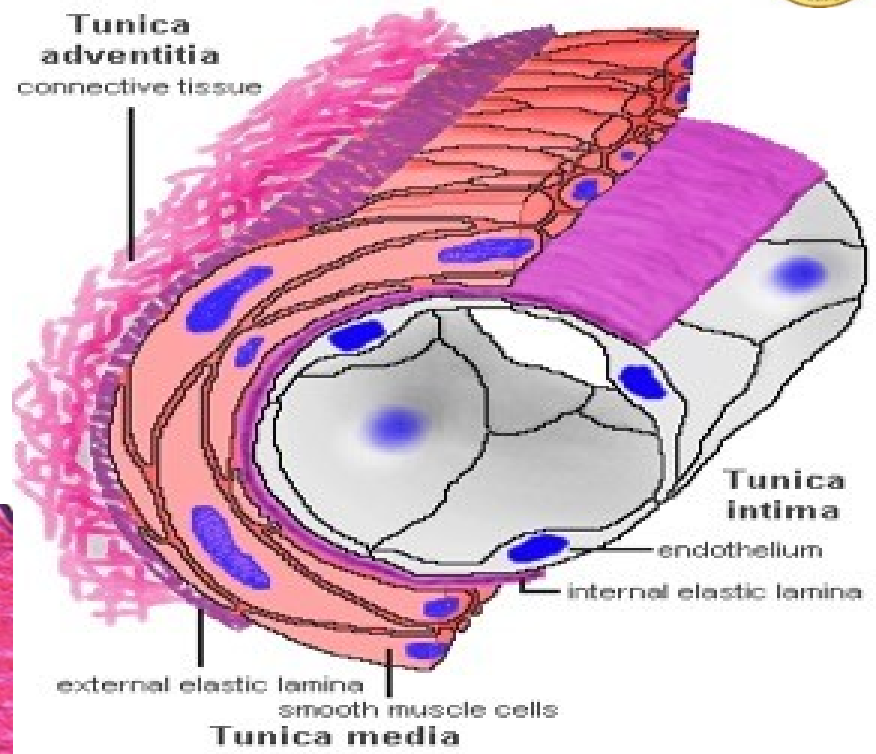

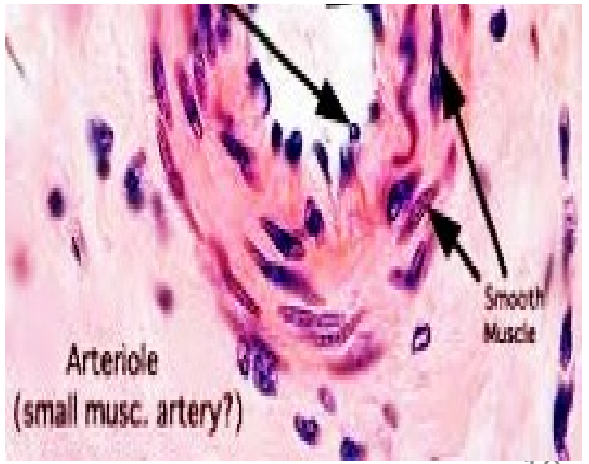

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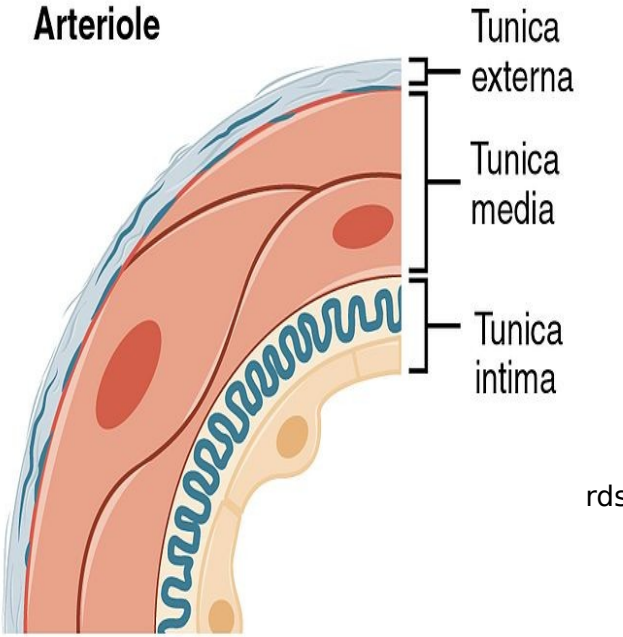
Arterioles



- Lumen diameter less than 100 μm.
- **Structure:** Narrow lumen, thin wall formed of:

T. Intima:

A- Endothelium: simple squamous cells with tight J. **B- Thin Subendothelial CT**

C- Internal elastic lamina; present only in large arterioles

T. Media:

-Thin layer.

-Formed of **2-3 layers of smooth muscle cells in large arterioles**

-**No EEL**

T. Adventitia:

-Very thin layer.

Regulate blood flow to the capillary bed….major determinant of blood pressure

Pulse rate is **72 beats per minute** and regular

What is missing in a full report of the arterial pulsation?

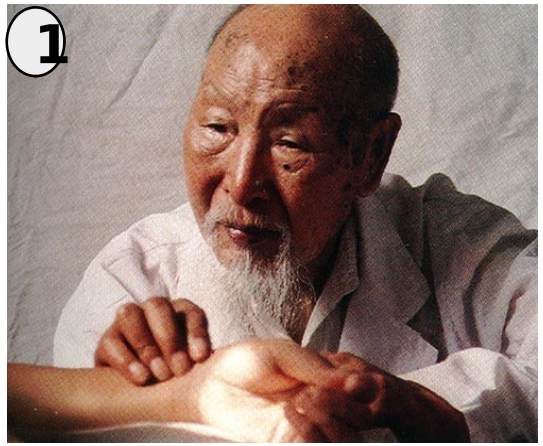
Comment

1. Rate
2. Rhythm
3. Volume
4. Equality
5. Special character of the pulse
6. Condition of arterial wall

Special character of the pulse (Patterns)

- Thready pulse

Final Comment on the Radial Puls



The Pulse is ....

80 beats /min, regular, average volume, with no special characters, equal on both sides, and the vessel wall is not palpable.

Pulse rate is **72 beats per minute** & regular

The full report missing volume, special characters, equality on both sides, and the condition of the vessel wall.

5- What would you do next to Maryham?

1-search for the cause (primary or secondary)

2-Assess effect of hypertension on other body systems (complications; cardiac, retina, renal)

3-Assess life style

An accidental discovery in a check up

The doctor examined the **eye fundi**

The doctor asked for **12 lead ECG**

e following Investigations were ordered

- Test for the presence of **protein in the urine** by sending a urine sample
- Plasma **glucose, electrolytes**.
- **Lipid profile, serum total cholesterol and HDL cholesterol**
- **Kidney function test**:

esults showed no detectable abnormalities

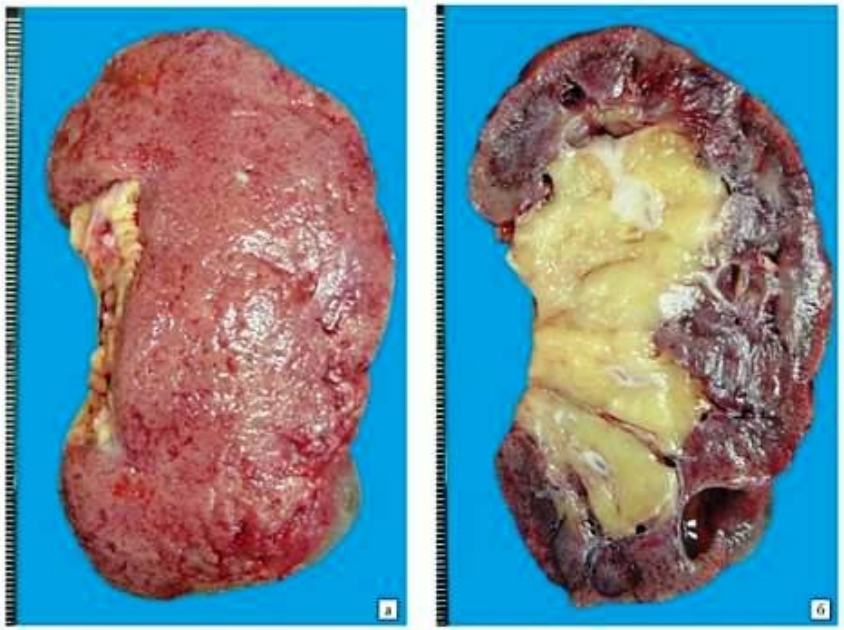
An accidental discovery in a check up

- Urine analysis ……**why?**
- **Kidney function tests:** Serum creatinine, estimated glomerular filtration rate **why?**

6- What are the pathological changes that could be seen in the kidney in this patient?

Benign nephrosclerosis:

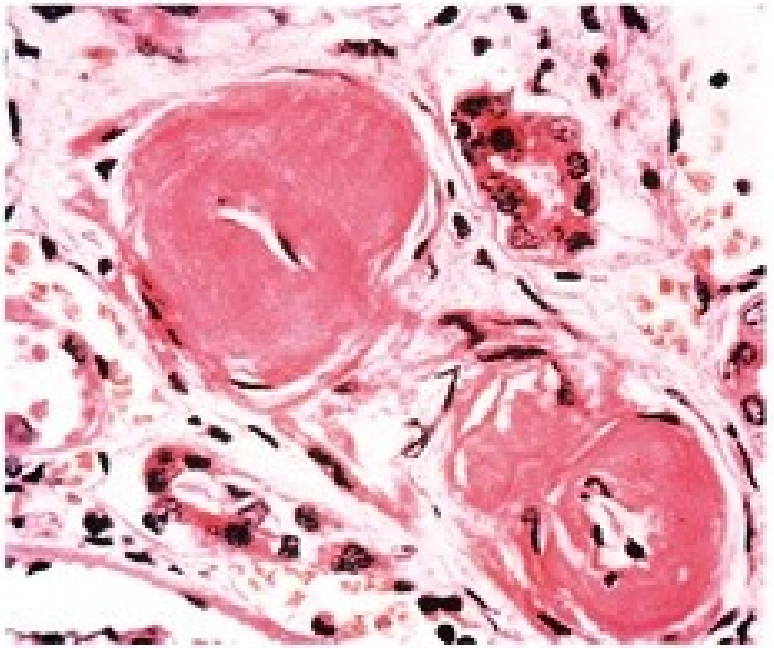
- **Small size**
- **Finely granular surface**
- **Adherent capsule**
- **Cortex and medulla are fibrotic, atrophic, not demarcated**
- **Thick prominent arterioles**
- **Apparent increase in peripelvic fat**



7- What are the pathological changes that could be seen in Small arteries & arterioles?

Hyaline arteriolosclerosis:

- **Hyalinosis of the intima & media with thickening of the vessel wall.**
- **Elastosis (splitting of internal elastic lamin**
- **Atherosclerosis is common**



8- How could you manage Maryham?

What life style changes are you going to suggest to Maryham?

- **Diet control**
- **Stop smoke**
- **Regular exercise**
- **Weight reduction**

Maryham will start an antihypertensive drug

Choices

ACE inhibitors / ARBs

Calcium channel blockers

β blockers

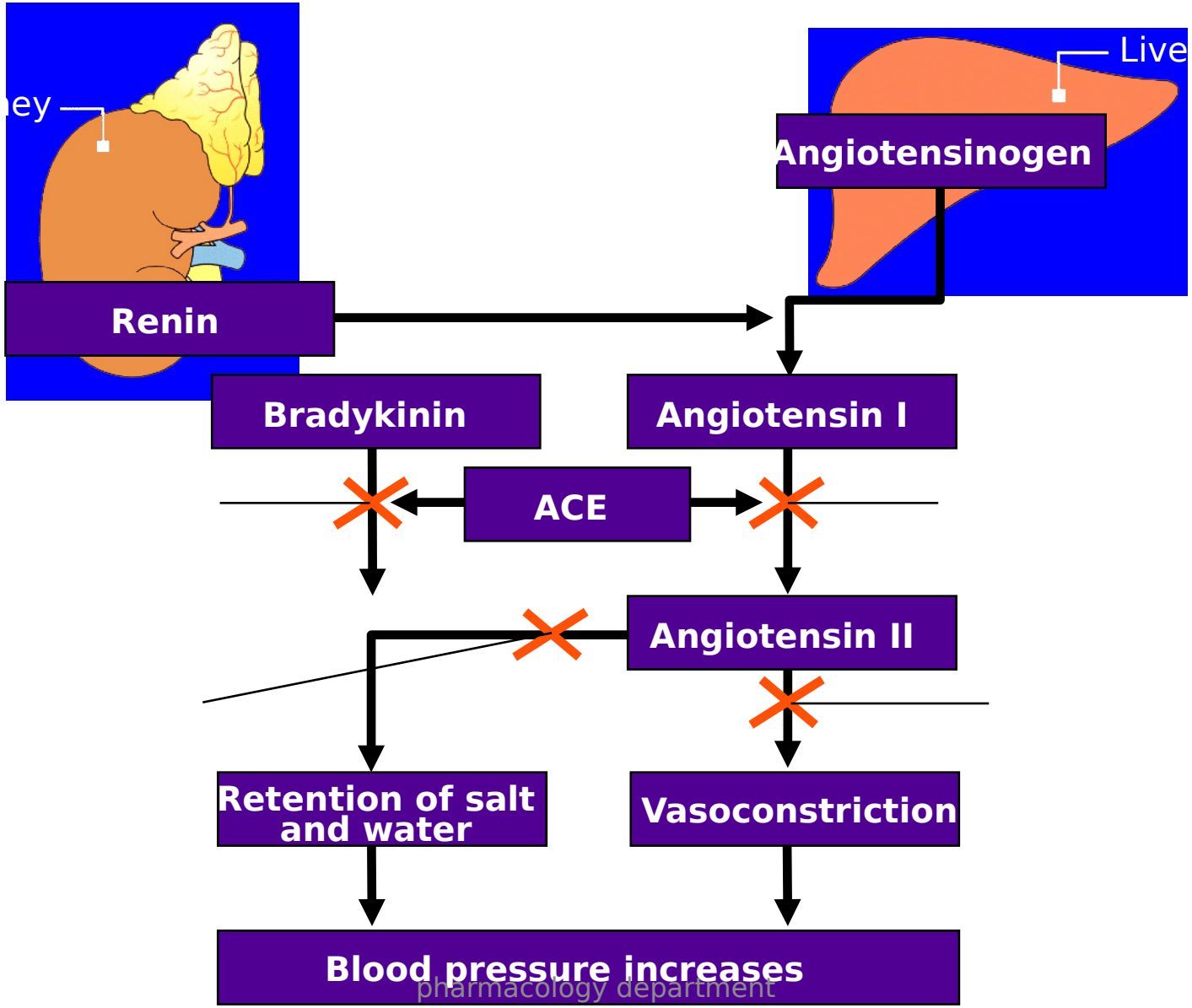
Diuretics

Maryham was given ACE inhibitors; perindopril 4 mg once daily orally

9- a-Mention the mechanism of action perindopril

b- What precautions should be taken in this therapy?

The renin-angiotensin-aldosterone system



Mention the mechanism of action perindopril

- It leads to both inhibitory action on the renin-angiotensin system and a stimulating action on the kallikrein-kinin system.
- Cardiac output and heart rate are not significantly changed.
- They do not result in reflex sympathetic activation and can be used safely in persons with ischemic heart disease.

1. Blocks Formation of angiotensin II ; P.R.
2. Aldosterone Release; Blood Vol.
3. Bradykinin; P.R.
4. Vasodilatation of the arterioles & venules; preload & afterload

What precautions should be taken in This therapy?

- **Concomitant use of ACE inhibitors with non- steroidal antiinflammatory drugs (NSAIDs) is discouraged,**

Nonsteroidal anti-inflammatory drugs may impair the hypotensive effects of ACE inhibitors by blocking bradykinin-mediated vasodilation

- **With potassium supplements or potassium-sparing diuretics, they can result in hyperkalemia.**

What are the most common side effects of perindopril?

Dry cough,
angioedema,
dysgeusia,
hyperkalemia

10- What could be a possible contraindication of perindopril in Maryham’s case?

Pregnancy as it is **teratogenic** because of the risk of fetal hypotension, anuria, and renal failure, sometimes associated with fetal malformations or death.

Take Home Messages

- Target BP ≤ 135/75 mmHg

- Patients with hypertension should be compliant for the antihypertensive medications to avoid serious complications (hypertensive emergencies).

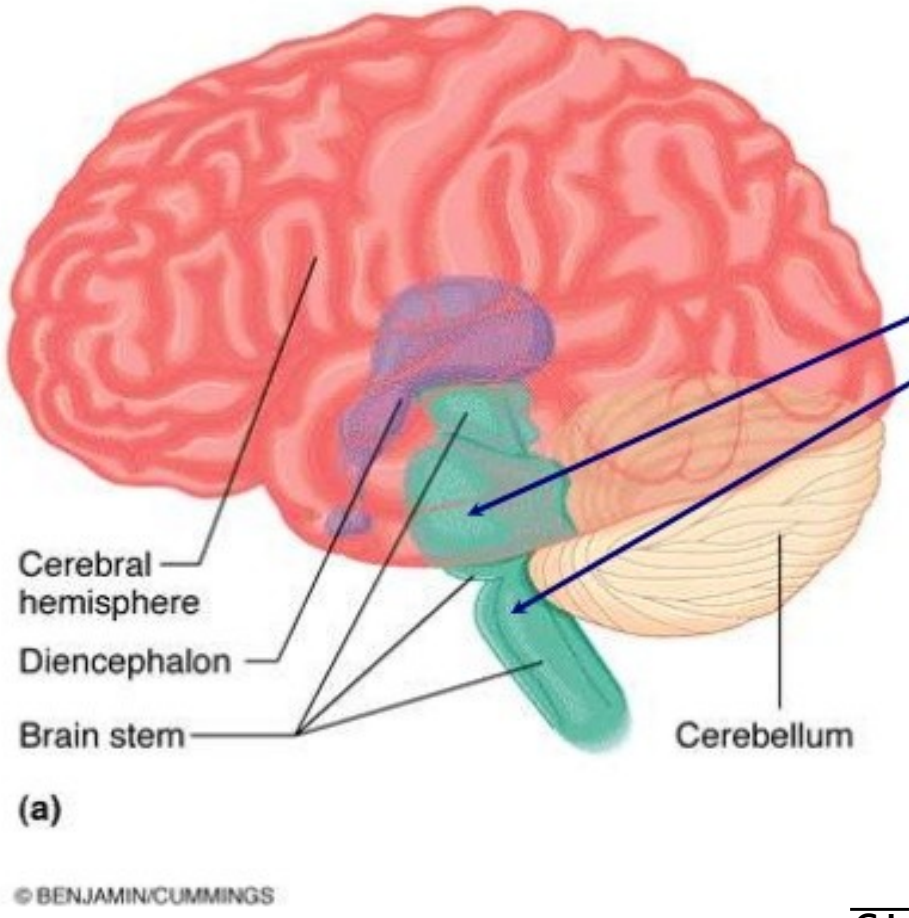
- Pharmacological treatment should comprise a regimen that includes either an ACEI or an ARB as first line.

Thank
you

Arterial blood pressure regulation

- **Rapid Nervous mechanisms**
- **Intermediate mechanisms**
  - Capillary fluid shift
  - Hormonal
- **Long term regulation**
  - Renin angiotensin system
  - Renal pressure natriuresis
  - Hormonal

Rapid Nervous mechanisms



Brainstem contains:

Pons
Medulla

In the Medulla are the:

Cardiac Acceleratory Centre
Cardiac Inhibitory Centre
Vasomotor Centre

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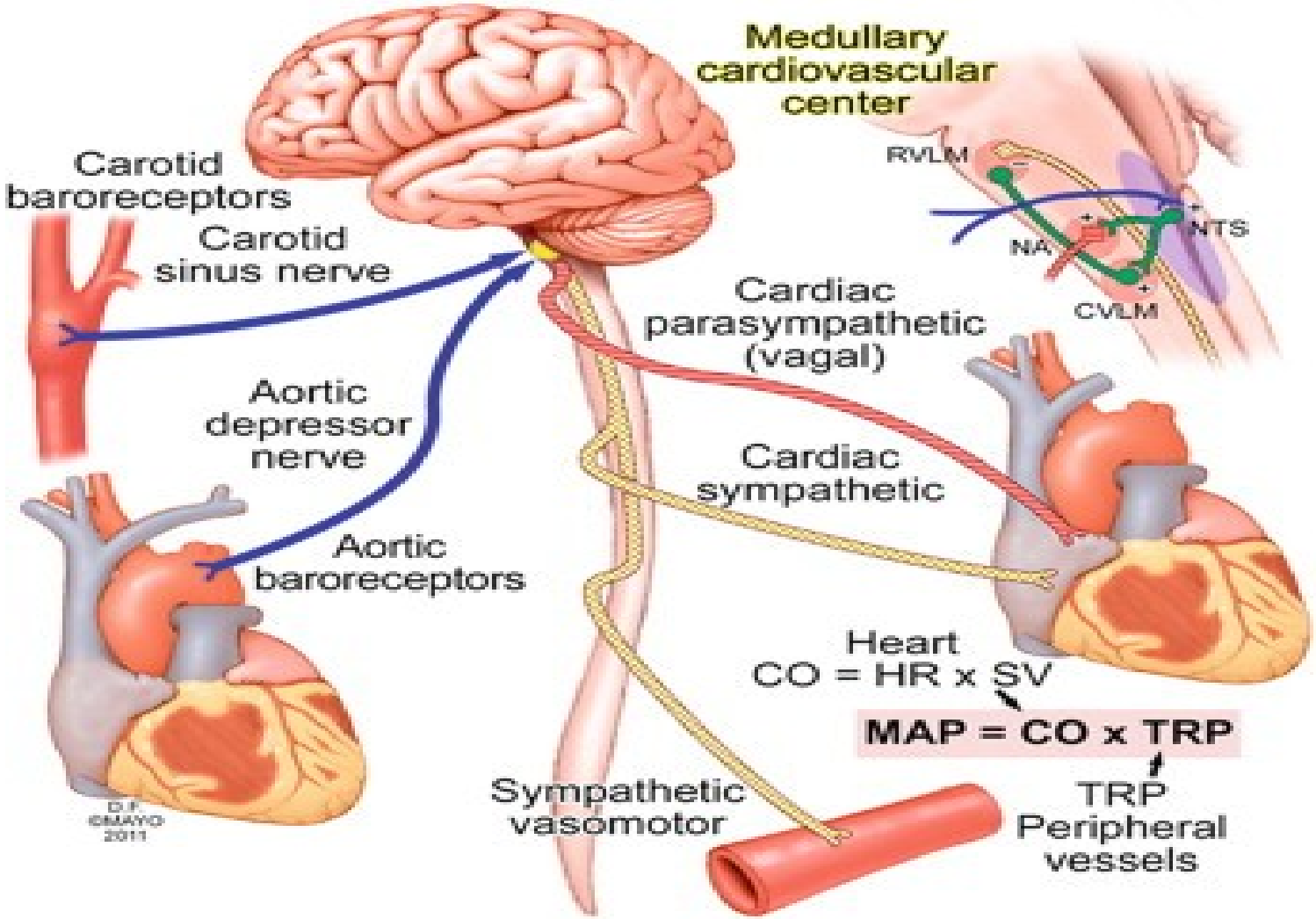
Rapid Nervous mechanisms



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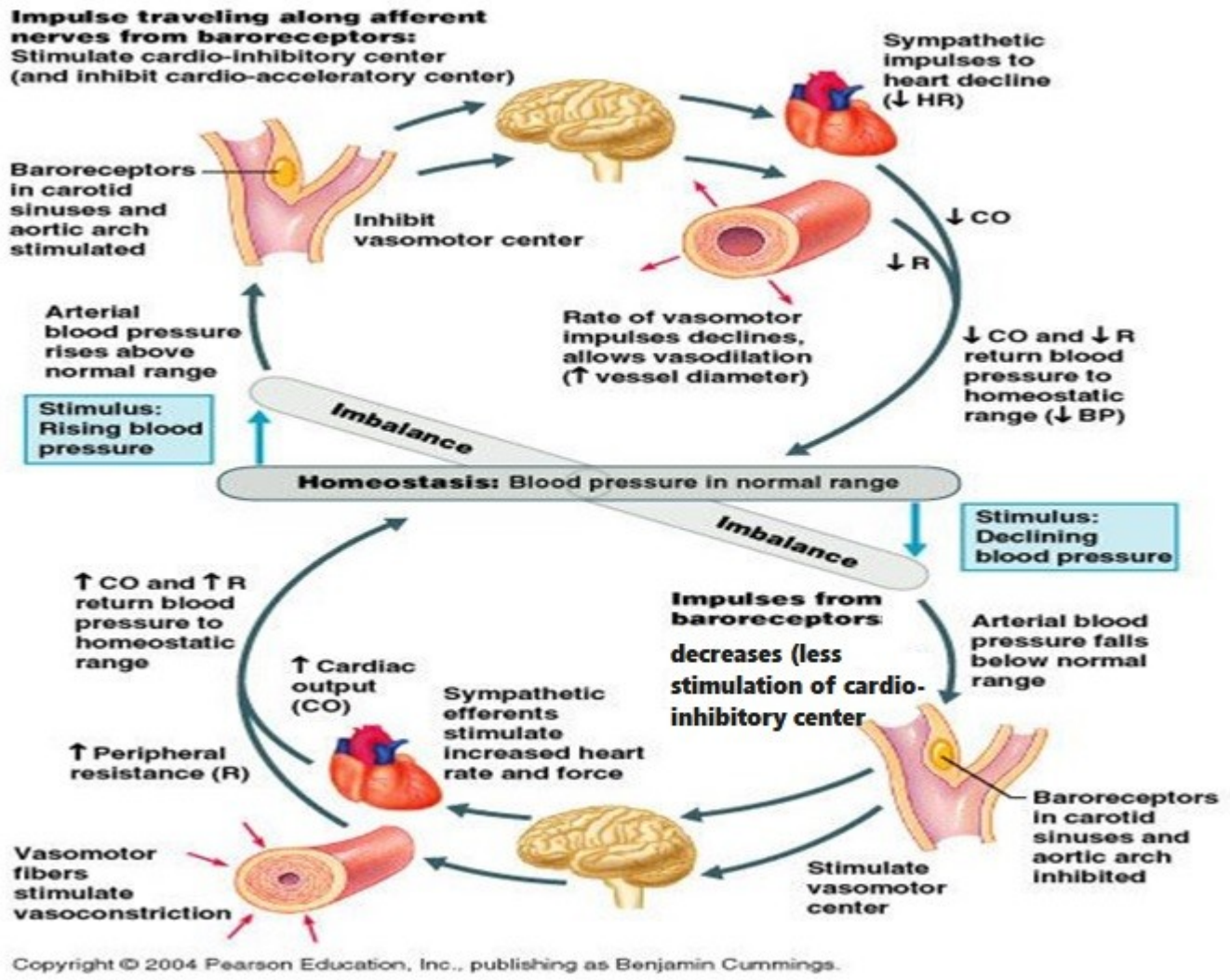
Rapid Nervous mechanisms


Impulse traveling along afferent nerves from baroreceptors: Stimulate cardio-inhibitory center (and inhibit cardio-acceleratory center)
Sympathetic impulses to heart decline (↓ HR)
Baroreceptors in carotid sinuses and aortic arch stimulated
Inhibit vasomotor center
↓ CO
↓ R
Arterial blood pressure rises above normal range
Rate of vasomotor impulses declines, allows vasodilation (↑ vessel diameter)
↓ CO and ↓ R return blood pressure to homeostatic range (↓ BP)
Stimulus: Rising blood pressure
Imbalance
Homeostasis: Blood pressure in normal range
Imbalance
Stimulus: Declining blood pressure
↑ CO and ↑ R return blood pressure to homeostatic range
Impulses from baroreceptors decreases (less stimulation of cardio-inhibitory center
Arterial blood pressure falls below normal range
↑ Cardiac output (CO)
Sympathetic efferents stimulate increased heart rate and force
↑ Peripheral resistance (R)
Baroreceptors in carotid sinuses and aortic arch inhibited
Vasomotor fibers stimulate vasoconstriction
Stimulate vasomotor center
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https://i.pinimg.com/originals/ac/78/12/ac781251aee9c7396473e598e80de127.jpg

Rapid Nervous mechanisms

Role of peripheral chemoreceptors:

Stimulus: Marked fall in ABP below 60 mmHg

(*e.g. Hemorrhage*)

↓↓Blood flow to these receptors → (*Hypoxia of chemoreceptors*)

→ →

Response: Peripheral chemoreceptors become stimulated

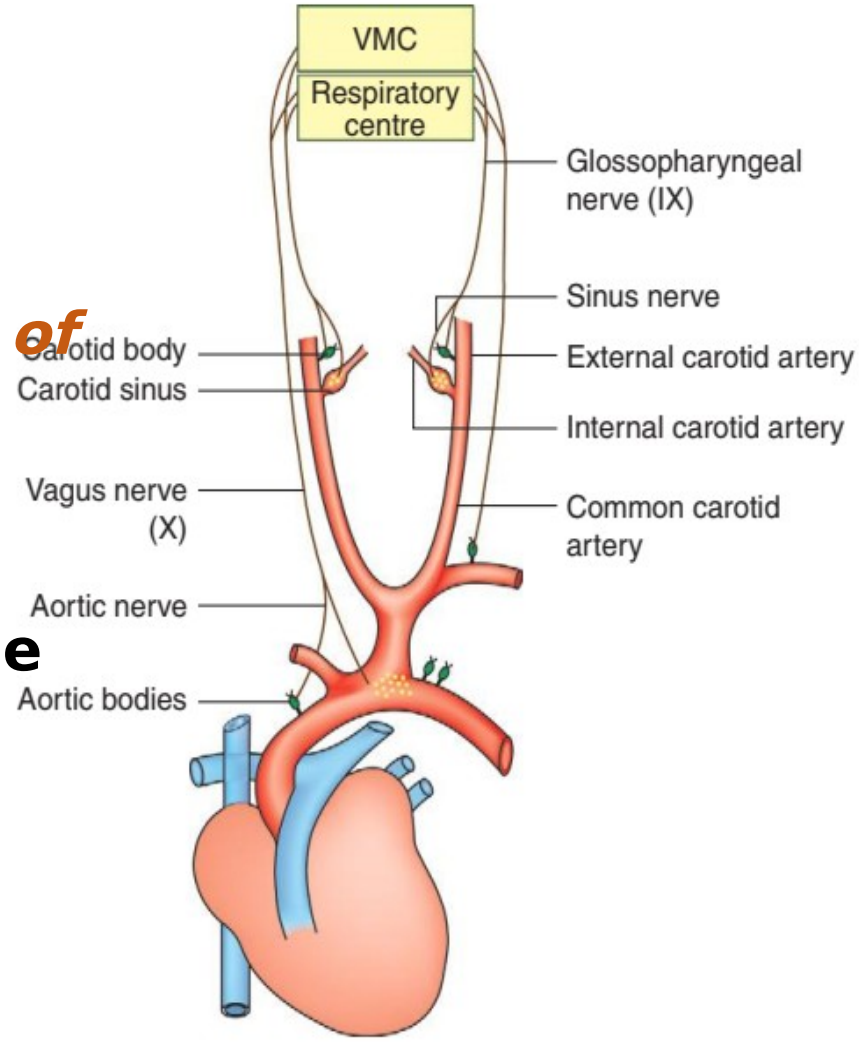
(++VMC)

Vasoconstriction

↑HR & CO

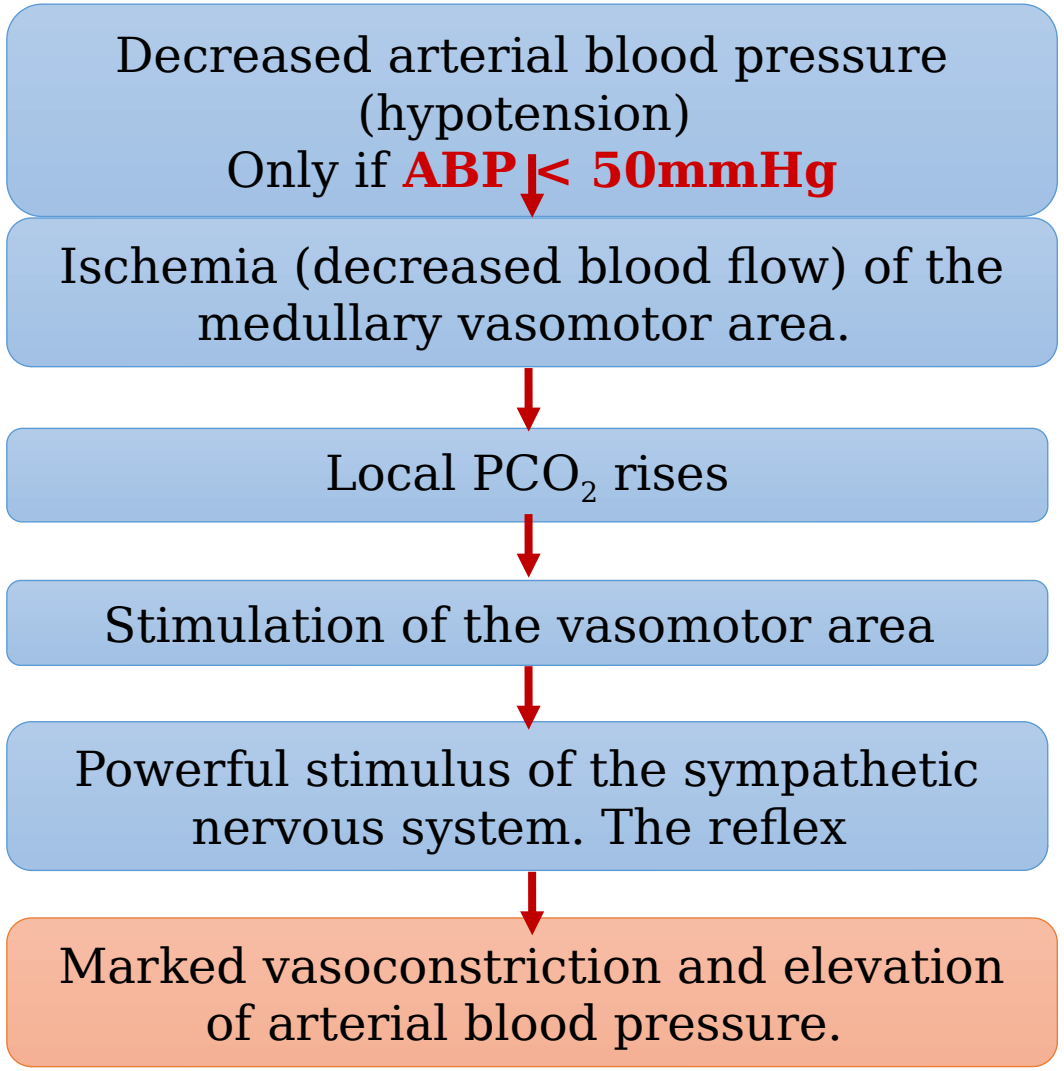
++ Respiration

Elevates ABP back toward normal



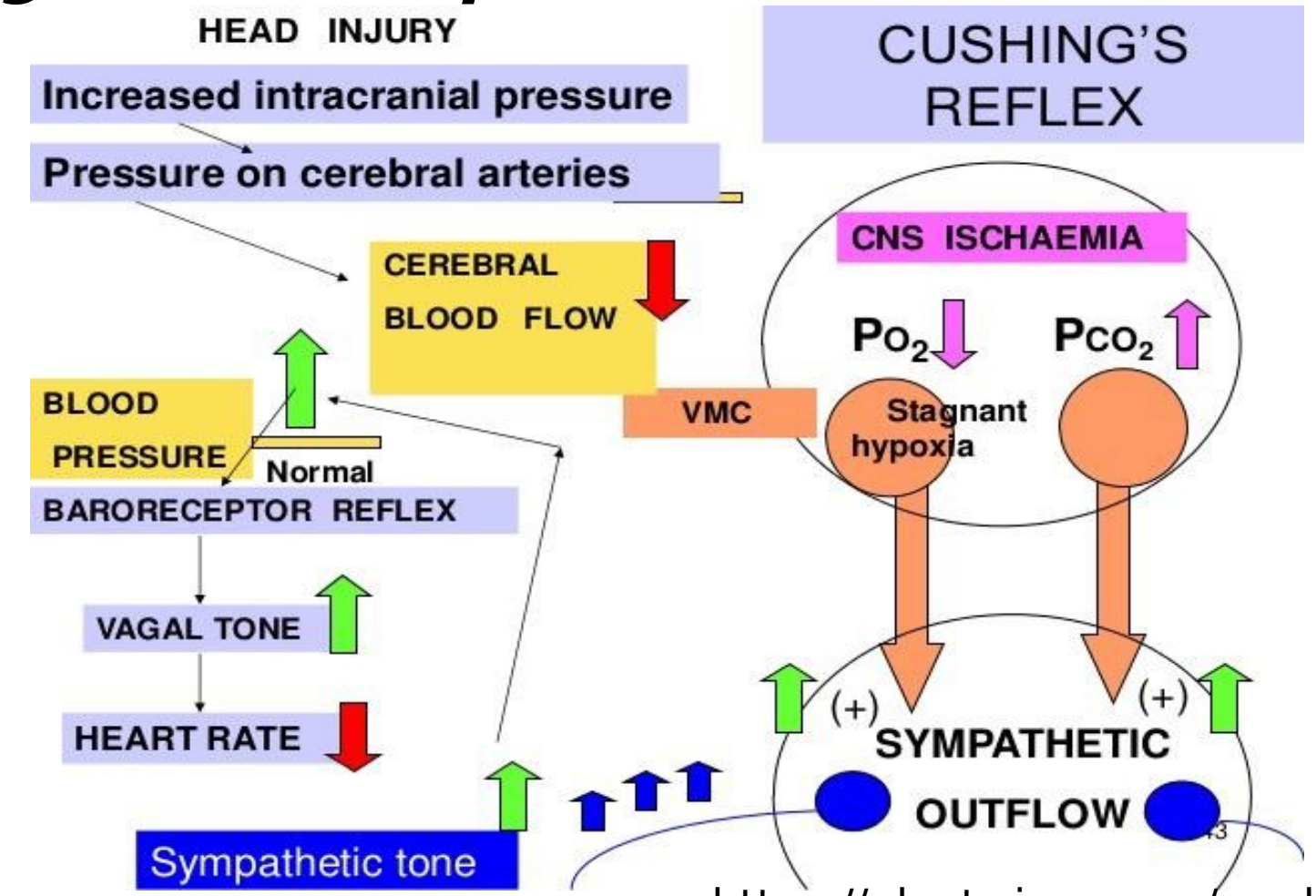
Rapid Nervous mechanisms

Brain ischemic response:


Decreased arterial blood pressure (hypotension)
Only if ABP ↓< 50mmHg
Ischemia (decreased blood flow) of the medullary vasomotor area.
Local PCO_2 rises
Stimulation of the vasomotor area
Powerful stimulus of the sympathetic nervous system. The reflex
Marked vasoconstriction and elevation of arterial blood pressure.

Cushing reflex:

Elevation of Bp accompanied by bradycardia (through baroreceptors)



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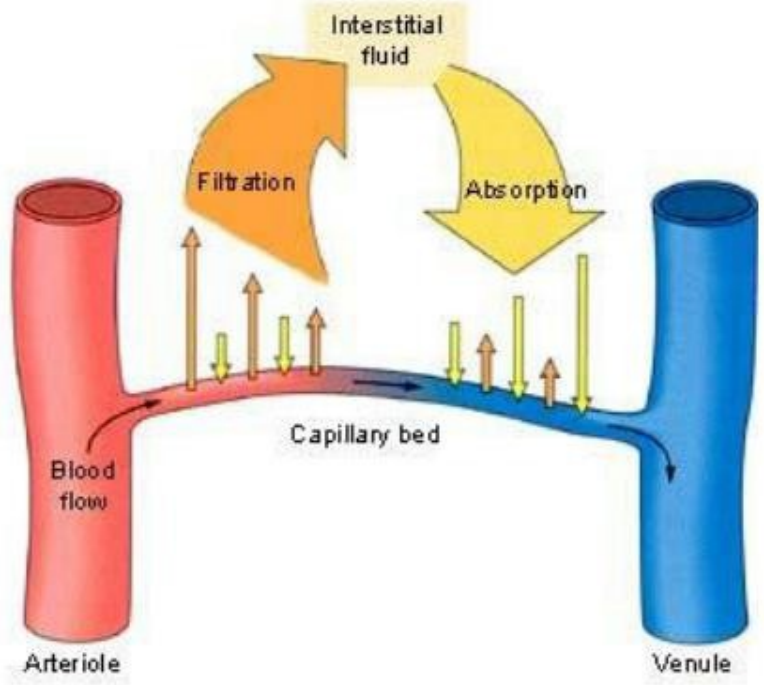
Intermediate mechanisms

1- Capillary fluid shift:

- Within minutes
- Starling forces at the level of the capillary bed
- Redistribution of fluid within the vascular-interstitial compartments



1. The fluid shift is a continuous process
2. Changes in MAP will alter the pressure gradients
3. Net fluid shifts can be altered dramatically

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Intermediate mechanisms

2- Hormonal regulation:

Adrenaline , Noradrenaline, Angiotensin II , Vasopressin.

Renin-Angiotensin System (RAS) vasoconstriction:

- Activation of RAS and formation of angiotensin II takes about 20-30 minutes.

- Angiotensin II raises arterial blood pressure by direct vasoconstrictor action and by activation of the sympathetic discharge.

Long term regulation

Operates over several days and responsible for longer term regulation though ECF volume regulation

1- Renal pressure natriuresis:

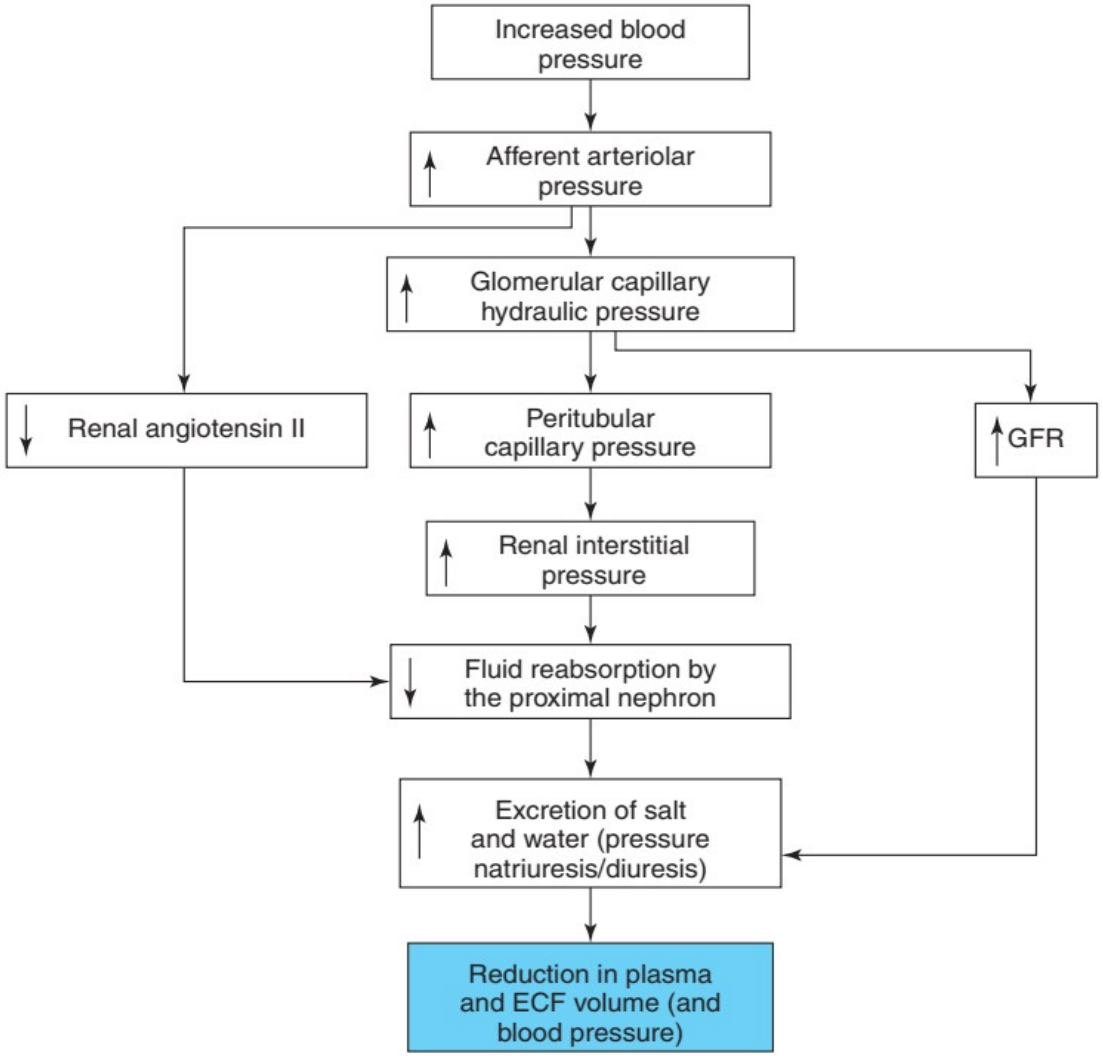
When arterial pressure is elevated, renal excretion of Na^+ and water is increases → decreasing the volume of ECF and lowering of arterial pressure to normal level.

Mechanism:

a. Increased GFR

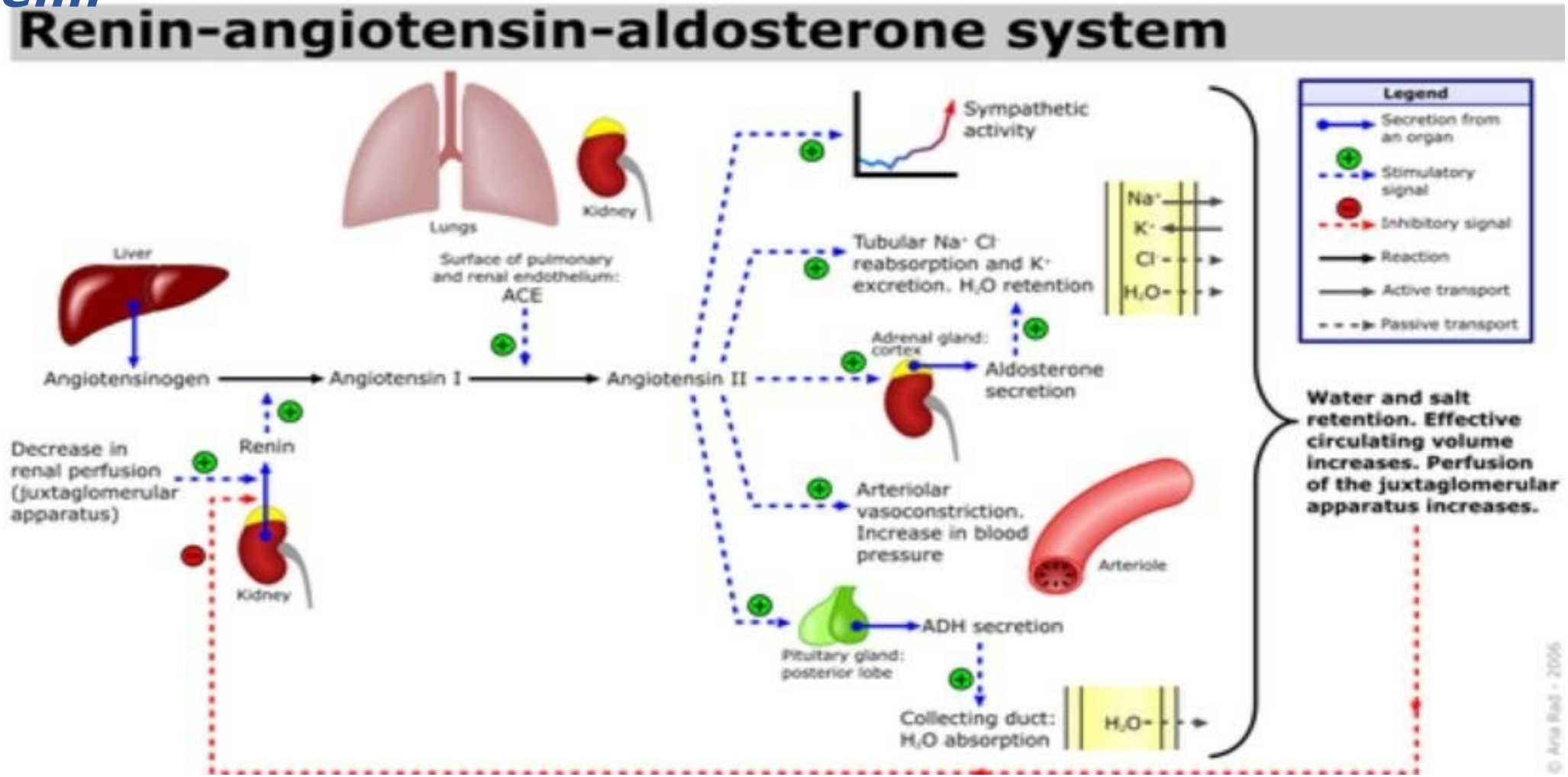
b. Decrease angiotensin II

c. Backleak of Na^+


Increased blood pressure
Afferent arteriolar pressure
Glomerular capillary hydraulic pressure
Renal angiotensin II
Peritubular capillary pressure
GFR
Renal interstitial pressure
Fluid reabsorption by the proximal nephron
Excretion of salt and water (pressure natriuresis/diuresis)
Reduction in plasma and ECF volume (and blood pressure)

Long term regulation

2- Renin-angiotensin-aldosterone system:



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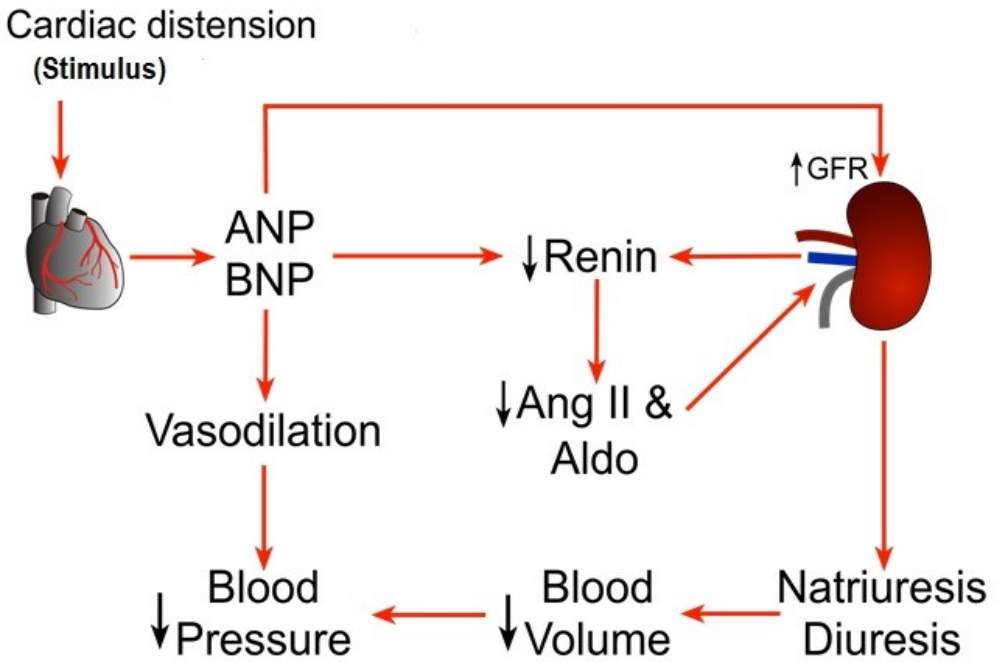
Long term regulation

3- Hormonal regulation:

A- Atrial natriuretic peptides (ANP) secretion:



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B- Anti diuretic hormone (Vasopressin) secretion: *with decreased ECF volume*

Case: Acute dyspnea

Acute dyspnea

Magdy is a 61 year old salesman. He lives in Heliopolis. He is married and has 3 children. Magdy travels frequently and eat junk food. He smokes 10 cigarettes/day.

He presented to the emergency room with **acute dyspnea**, with frothy pink sputum .

Acute dyspnea

Past history: hypertension for which he occasionally took thiazides. He has been diabetic for the last 5 years

Drug history: hydrochlorothiazides.
Diamacron and metformin

Family history: Mother ----- hypertensive on capoten
Father ----- stroke (residual left hemiparesis)

Acute dyspnea

General examination

Vital signs

- Pulse rate: 110 beats/minute
- BP **190/120** mmHg
- Temperature: 37°C

Obese: Weight 98 kg, **BMI 35** kg/m2

Chest: bilateral crepitations all over.

Heart tachycardia with gallop

Fundus examination showed Bilateral papilledema and retinal hemorrhages

What is the provisional diagnosis of Magdy?

What is the degree of hypertension in Magdy?

- **Malignant hypertension** , with end organ damage (acute left sided heart failure, and papilledema with retinal hemorrhage) which means that the patient has hypertensive emergency.
- Type 2 DM.

❑ Hypertensive urgencies:

- Severe BP elevation in stable patients without acute or impending change in target organ damage.
- These patients are **non-compliant with anti-hypertensive** therapy.
- They are treated by:
  - **Reinstitution or intensification of antihypertensive drug** therapy
  - Treatment of **anxiety** as applicable.
  - No need for **Referral to the emergency department**,

  Or Immediate reduction in BP in the emergency department.

Hypertensive emergencies:

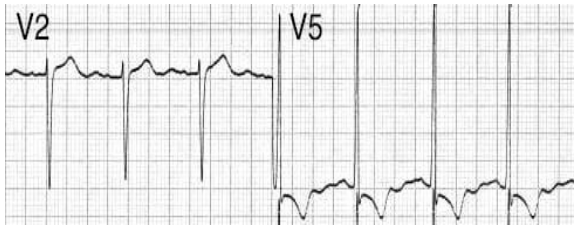
- Severe blood pressure elevation with evidence of end organ failure eg:
- the most common clinical presentations of hypertensive emergencies are cerebral infarction (24.5%), pulmonary edema (22.5%), hypertensive encephalopathy (16.3%), and congestive heart failure (12%). Other clinical presentations associated with hypertensive emergencies include intracranial hemorrhage, aortic dissection, and eclampsia, as well as acute myocardial infarction, and retinal and renal involvement.

Acute dyspnea

The doctor gave Magdy **intravenous frusemide** and asked for the following investigations and admitted him to the ICU

Investigation results:

- HbA1c: 9.2 %
- FBS: 160 mg/dl
- Creatinine: 1.2 mg/dL
- e-GFR: 88 ml/min/1.73 m2
- 24h urinary protein: 200 mg/24h
- **ECG: LVH** (left ventricular hypertrophy



The doctor prescribed **2 anti-hypertensive drugs** and told him to lose weight and follow a healthy life style.

The doctor gave Magdy **intravenous frusemide**

What is the mechanism of action of frusemide?

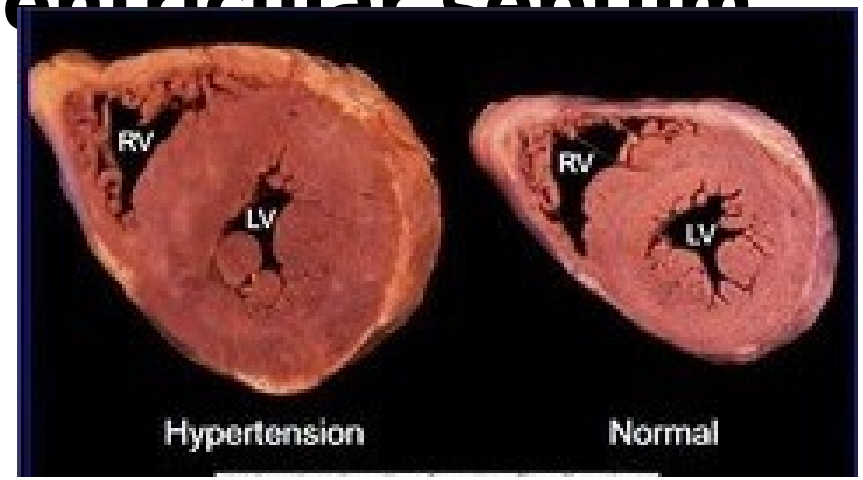
What is the mechanism of action of frusemide?

- Loop diuretics inhibit the cotransport of $Na^+/K^+/2Cl^-$ in the luminal membrane in the ascending limb of the loop of Henle.
- The loop diuretics are the most efficacious of the diuretic drugs.
- Excess Na will reach D.C.T. where a part of Na is reabsorbed in exchange of H^+ and K^+.
- Remaining of Na will be excreted in urine with water
- They ↑ renal blood flow → can be used in patients with renal insufficiency.
- No direct arterial V.D.
- Antagonized by probenecid

ECG: LVH

What are the pathological changes that can occur in the heart in Magdy?

- **Marked concentric hypertrophy of Lt. V.**
- **Bulge of interventricular septum towards Rt. V.**



How would you manage Magdy?

- 1- Admit to icu
- 2-Reduce Bp by max 25% over first hour then 160/100-110 mmHg over next 2-6h, then to normal over next 24-48h.
- The preferable antihypertensive agents in case of hypertensive emergency with acute heart failure is **iv or oral nitroglycerine and enalaprilat plus diuretics.**
- Proper control for blood sugar.
- Exercise, dash diet .
- Refer to ophthalmologist.
- Close Bp monitoring after discharge and encourage compliance for medications.